A STUDY OF THE ABUNDANCE DISTRIBUTIONS ALONG THE MINOR AXIS OF THE GALACTIC BULGE

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ABSTRACT

We derive the heavy element abundances for hundreds of K-giants in seven windows of low extinction, along or near the minor axis of the Galactic bulge. By using the recently-calibrated Washington photometric filter system, the distribution function in [Fe/H] is determined for each field. Within 8° of the Galactic center (~ 1 kpc) our data are consistent with no gradient in the distribution of [Fe/H], which may hint to a dissipationless collapse, and/or sufficient mixing during the star-forming epoch when Fe was produced in the bulge. The mean abundance over this region is between two and five times solar. The form of these distributions is well-fitted by the simple (closed box) model of chemical evolution where the bulge is self-enriched by processing its original gas content to completion. Beyond 8° from the Galactic center, our data show that the mean of the abundance distributions drops precipitously. This is consistent with the notion that the inner bulge is chemically distinct from the halo.

1. OBSERVATIONS

We used the recently calibrated Washington photometric system (Geisler, et al. 1991) to obtain photometric abundances for hundreds of K-giants in seven low extinction windows to the Galactic bulge. The data were obtained on the 0.9m telescope at CTIO. Abundances accurate to ±0.25 dex in [Fe/H] were derived for each K-giant using the metallicity-sensitive indices of the Washington system. (For a recent review of the Washington system see Tyson 1991).

2. ABUNDANCE DISTRIBUTIONS

The shape of the stellar abundance distribution holds valuable information about the history of chemical enrichment in a system. The distributions for the inner fields (i.e. $b = -2.7°, -4°, -6°$) bear a remarkable resemblance to the gaussian-convolved abundance distribution of the closed box, simple model of chemical evolution (Searle & Zinn 1978, also Rich 1990). Fig. 1 displays the abundance distribution for the inner-most field of this study. Error bars represent the typical errors in precision for a single observation derived from the photometric uncertainties. There is the

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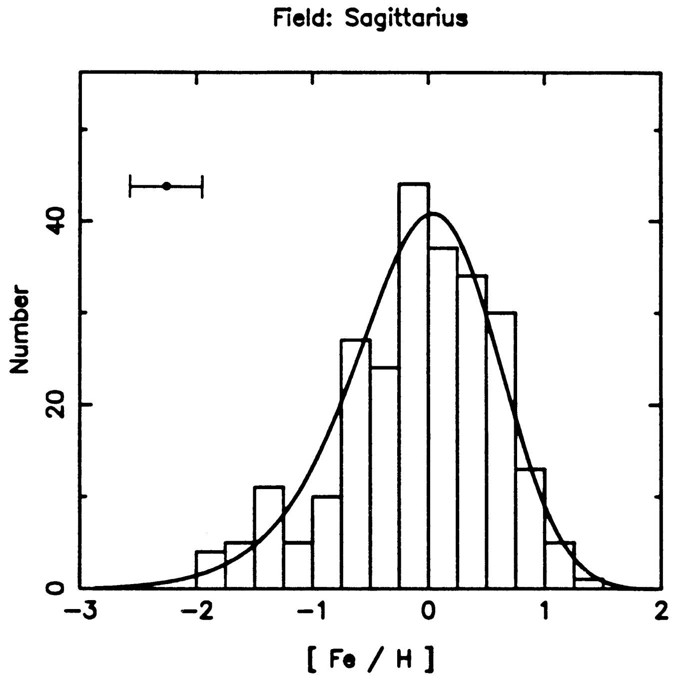

Figure 1 Abundance distribution for the Sagittarius field ($b = -2.7°$) overlaid with an error-convolved distribution expected for the closed box simple model of chemical evolution.. There is remarkable agreement with the abundance distribution expected from the simple model of chemical evolution where a system has processed completely its original gas supply. The characteristic features are immediately apparent, such as the long low abundance tail, and the relatively steep high abundance shoulder. The error bar represents the errors in photometric precision.

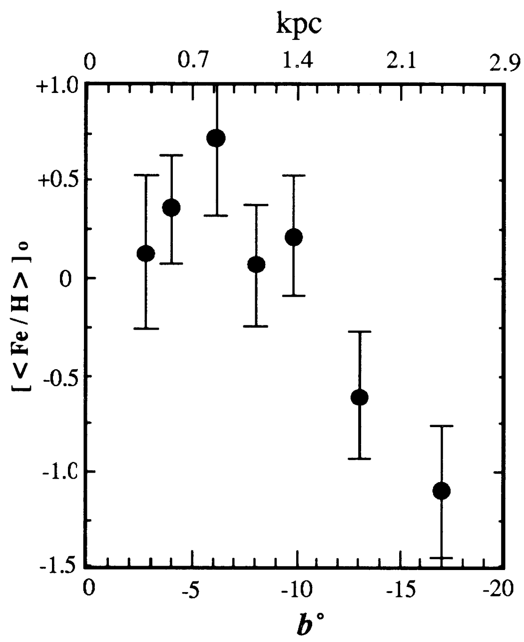

Figure 2. Galactic latitude dependence of the mean in the abundance distributions. Plotted is the error-corrected log of the mean abundance at all latitudes. The mean abundance does not show a trend downward until beyond ~ 1 kpc. The similarity among the inner latitudes in their mean abundance suggests strongly that the bulge, within about 1 kpc, followed common evolution. The similarity and shape of the abundance distributions for the inner fields suggests a common evolution described by the closed box simple model of chemical evolution.

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characteristic extended tail toward lower abundances and the relatively steep shoulder at high abundance. Consequently, our data suggest that the bulge abundance distributions, out to $b = -6°$, are consistent with a fully mixed, closed box, simple model of chemical evolution that has processed its gas to completion.

3. DISCUSSION

To supplement interpretation of the abundance distributions we can look at the run of the log mean abundance, [<Fe/H>], as a function of Galactic latitude. This constitutes the first direct measurement of the latitude dependence of [Fe/H] in the Galactic bulge. Fig. 2 presents these data. The errors are large, but two convincing features are immediately apparent: [1] The inner latitudes stay at roughly constant mean abundance [Fe/H] $\approx 0.4 \pm 0.3$ ($r < 1$ kpc), which suggests that the bulge, within about 1 kpc, is a chemically well-mixed volume. There is a small trend for [<Fe/H>] to drop within $b = -6°$, but given the relatively large errors, it is not clear whether much should be made of this feature. The fact that the abundance distributions for the three inner latitudes show good agreement with the analytic form of the abundance distribution from the closed box simple model suggests strongly that the inner bulge is self-enriched. [2] Outside of the inner 1 kpc, the mean abundance begin a precipitous 1.5 dex drop to latitude $b = -17.3°$. This drop is remarkable when we consider that it occurs over just 1 kpc. The 1σ error bars in Fig. 2 are computed from the photometric *and* zero-point errors. The statistical uncertainty in the mean abundance ($\sigma / N^{-1/2}$) for each field is considerably smaller.

4. FUTURE

One of the most useful aspects of the Washington system is its ability to flag interesting stars of unusually high (or low) abundance for follow-up spectroscopy. As emphasized by D. Terndrup at this conference, the idea of a kinematic dependence on abundance in the Galactic bulge is an exciting topic that demands much further study. In collaboration with D. N. Spergel (Princeton), we plan to obtain medium resolution spectra of the highest and lowest abundance stars from the abundance distributions of this study. Spergel has developed computer models of the Galactic bulge that allow one to derive observable quantities from segregated orbit families in phase space. We expect this approach to be a powerful analytic tool that will enable interpretive leverage on abundance and velocity distributions that would not otherwise be possible.

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